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REPORT

A wide-deviation f.m. receiver

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A WIDE-DEVIATION FM RECEIVER

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Summary

This report describes two, simple, wide-deviation f.m. receivers, one operating in the frequency range 40 MHz to 50 MHz, the other in the range 88 MHz to 100 MHz. The receivers are intended for use with an f.m. system similar to that of the existing v.h.f. f.m. service, but with four times the peak frequency-deviation; they are intended for use in future work on the comparison of different modulation systems. A brief specification of one of these receivers is given, together with measured performance characteristics.

Issued under the authority of

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1. Introduction

The existing v.h.f. frequency-modulated stereophonic transmission system uses a maximum frequency-deviation of 75 kHz. In future, there may be applications which require a better signal-to-noise ratio in the outer parts of the service area than is obtainable with this existing system and so other means of programme transmission will be necessary. One possibility is to adopt an f.m. system of wider-deviation, say, ±300 kHz. Since no commercial receivers are available to carry out an investigation of this type it was decided to make a simple receiver using, as far as possible, existing commercial modules. Two versions of the receiver have been made, one tuning from 40 MHz to 50 MHz in Band I and the other in Band II from 88 MHz to 100 MHz. In this report, only the Band I receiver is described. Except where stated the Band II receiver may be taken as having a similar performance.

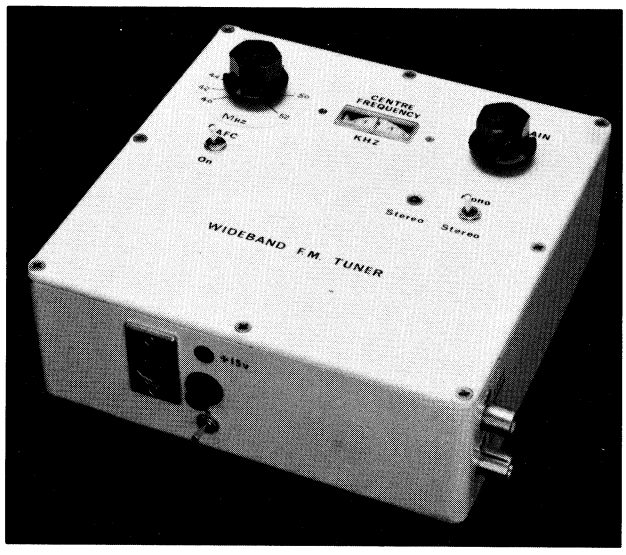

Fig. 1 - The wide-deviation f.m. receiver

Fig. 1 is a photograph of one of the receivers.

2. Brief specification

The receiver is intended to operate with stereophonic broadcast transmissions similar to those at present radiated in Band II, but with four times the frequency-deviation, i.e. a peak deviation of ±300 kHz.

As far as was practicable, the receiver used existing commercial modules and was intended to be representative of that which might be adopted by a manufacturer in the future if a wide-band f.m. service were introduced.

A brief specification for a simple receiver of this type was drawn up on the basis of experience with conventional f.m. receivers; the specification is given below:

Input signal frequency range	40 to 50 MHz
Input impedance	75 ohms unbalanced
Peak frequency-deviation of input signal	±300 kHz
RF & i.f. bandwidth (–3 dB)	700 kHz
(–60 dB)	1·5 MHz
A.F.C. pull-in range	±200 kHz
A.F.C. gain	15
De-emphasis time-constant	50 μs
A.M. suppression (40 μV to 20 mV r.f. input)	> 30 dB
A.F. output level (into 600Ω load, unmatched)	+6 dBm at max. deviation
A.F. response, both stereo channels (after de-emphasis) 10 Hz to 15 kHz	±½ dB
Subcarrier suppression 19 kHz	> 35 dB
Subcarrier suppression 38 kHz	> 35 dB
Total harmonic distortion	< 1%
Stereo crosstalk 50 Hz to 2 kHz	< –30 dB
30 Hz to 15 kHz	< –24 dB

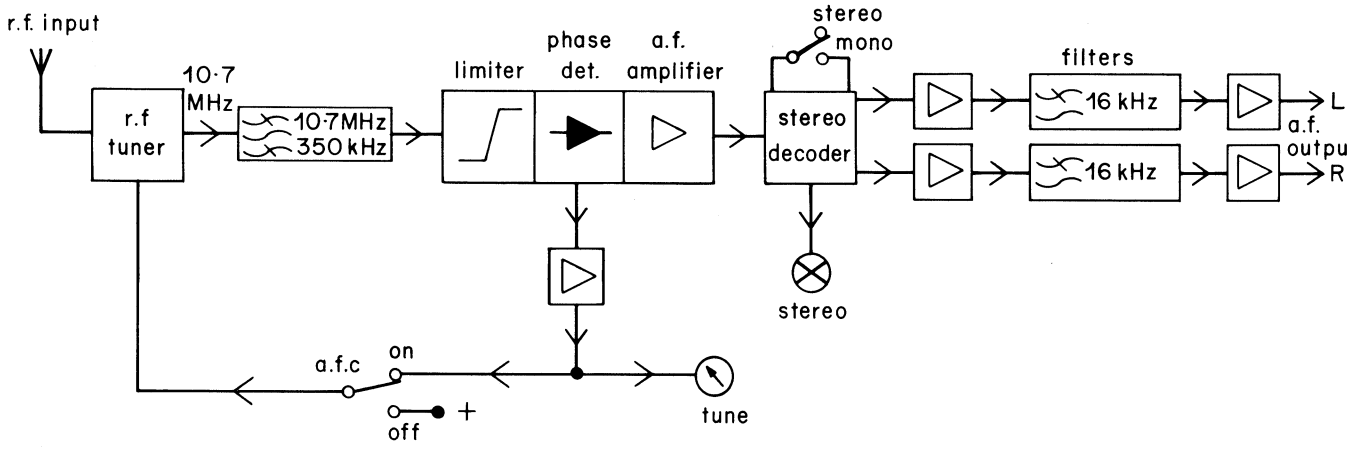

Fig. 2 - The wide-deviation f.m. receiver

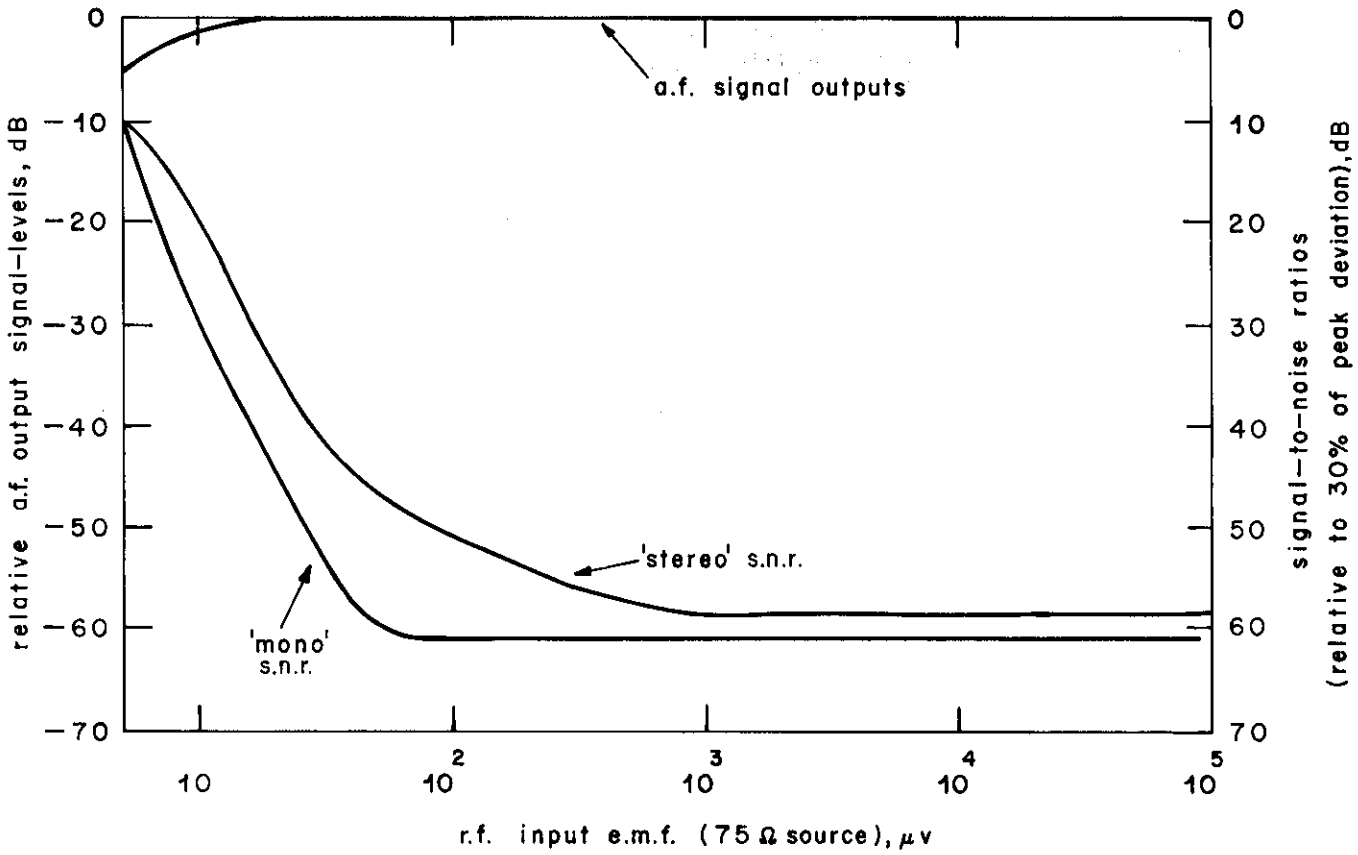

Fig. 3 - Typical output levels and noise performance

3. Circuit description

Fig. 2 shows a block diagram of the receiver, which consists of five main sections:

1. A radio-frequency tuner unit.
2. An intermediate-frequency filter, amplifier and detector unit.
3. A stereo decoder.
4. Audio amplifiers.
5. Power supply.

The r.f. tuner unit is a commercial tuner Mullard type LP1186, with the i.f. tuned-circuits modified to give a 700 kHz overall bandwidth. The r.f. coils were changed to provide the appropriate tuning range (40 MHz to 50 MHz) for use in Band I. A buffer amplifier on the output of the r.f. tuner unit supplies the main 10·7 MHz i.f. filter.

The intermediate frequency filter is a five-tuned-circuit Cohn filter with a 0·1 dB ripple Tchebyscheff response. This filter drives an integrated-circuit limiter and quadrature detector. The 'Q' of the tuned circuit in the quadrature-detector was chosen so as to give a satisfactory compromise between noise and distortion. A low-level audio amplifier is included in the same integrated circuit, the output from this amplifier driving the stereo decoder.

The push-pull outputs from the quadrature detector are low-pass filtered before being amplified by a differential amplifier which drives the tuning meter and provides the automatic-frequency-control (a.f.c.) signal to the r.f. tuner. The range of the tuning meter is ±10 kHz at the intermediate frequency. With a.f.c. 'on', this corresponds approximately to tuning errors of ±150 kHz at the r.f. input frequency. The maximum correction attainable by the a.f.c. loop is limited to ±200 kHz.

The stereo decoder is a standard commercial decoder (Mullard type LP1400) and is fitted with a stereo-indicator lamp. A switch is provided for manual changeover between stereophonic and monophonic reproduction.

The outputs of the decoder drive buffer amplifiers

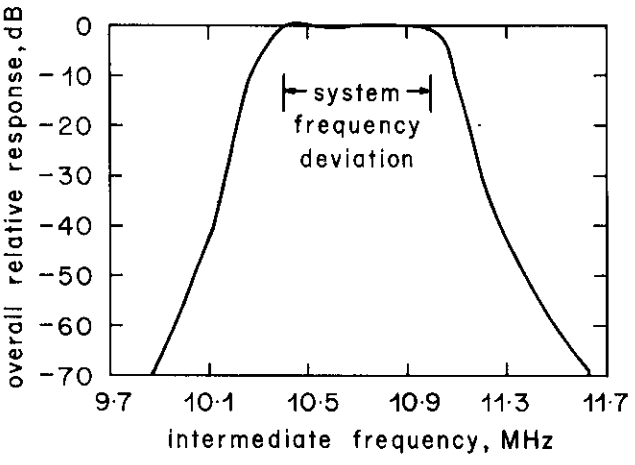

Fig. 4 - Overall r.f. - i.f. response

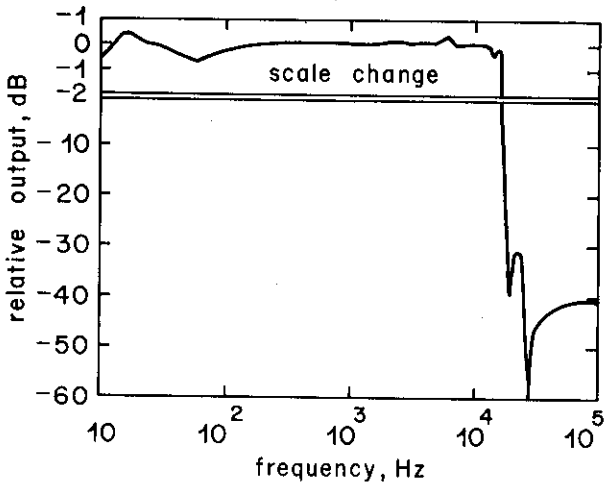

Fig. 5 - Audio-frequency response

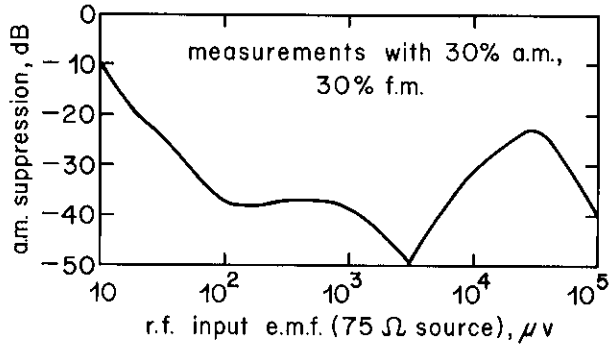

Fig. 6 - Typical a.m. suppression ratios

whose outputs are fed to low-pass filters which remove the residual 19 kHz and 38 kHz components. These filters are followed by simple output amplifiers.

4. Performance

The noise performance of the r.f. tuner is determined by the commercial tuner unit and is shown in Fig. 3. The Band II receiver has a slightly poorer noise performance.

Fig. 4 shows the overall r.f.-i.f. response. Fig. 5 shows the modulation frequency response of the receiver whilst Fig. 6 shows a typical plot of the a.m. suppression ratio as a function of the r.f. input signal level.

The stereo cross-talk performance is determined by the characteristics of the commercial decoder module, which was found to give more than 30 dB separation over the frequency range of 50 Hz to 2 kHz, reducing slightly outside this range.

It can be seen that the performance substantially meets the specification given in Section 2.

5. Conclusions

Simple frequency-modulation receivers, that are likely to be typical of commercial designs if wide-deviation f.m. (±300 kHz) broadcast transmissions are adopted, have been constructed and tested. One receiver has been built to operate at the lower end of Band I; another has been built to operate in Band II. Tests on the receivers show that they meet the specification given in Section 2. It is considered that they are adequate for tests with any wide-deviation f.m. broadcast transmissions that may be carried out in the future.